

What is claimed is:

1. A laser processing method to a glass substrate, comprising the steps of:

forming a thin film of a material showing superior  
5 absorption characteristics of a laser beam to that of the glass substrate, on a surface of which said thin film is formed;

radiating the laser beam having an intensity distribution onto said thin film; and

10 removing the thin film depending on the intensity distribution of the laser beam by fusion, evaporation or ablation which occurs by making said thin film absorb energy from the laser beam radiated thereon, wherein

said thin film is made of inorganic material, and  
15 a thickness or an absorption index of said thin film with respect to the laser beam is set at a value less than a threshold value that is enough for the laser beam to reach a surface of said glass substrate penetrating through said thin film to cause the fusion, evaporation or ablation.

20 2. A laser processing method to a glass substrate as defined in Claim 1, wherein

for the absorption index with respect to the laser beam, there is applied any one of the following methods, including a method of intensively introducing a shift in a  
25 ratio of quantum theory, such as of defective oxygen, a method of introducing a defect, a method of doping an ion showing high absorption with respect to wavelength, a method of mixing amicros or ultra fine particles, a method of mixing a pigment, or a method of mixing an organic pigment.

3. A laser processing method to a glass substrate as defined in Claim 1, wherein the laser beam is a laser beam having a periodic optical intensity distribution.

4. A laser processing method to a glass substrate as  
5 defined in Claim 3, wherein the laser beam having a periodic optical intensity distribution is obtained by a phase mask.

5. A laser processing method to a glass substrate as defined in Claim 3, wherein the laser beam having a periodic optical intensity distribution is obtained by interference  
10 of the laser beam.

6. A laser processing method to a glass substrate as defined in one of Claims 1 through 5, wherein said thin film is coated by a single layer or a plurality of layers of one or any combination of a glass of a metal oxide, a metal  
15 nitride, a metal carbide, a semiconductor, and silicon dioxide ( $\text{SiO}_2$ ), a fluoride glass, and a chalcogenide glass.

7. An optical diffraction element for use as a diffraction grating or a hologram installed in a device such as an optical coupler, a polariscope, a wave divider, a  
20 wavelength filter, a reflector or a mode transducer, wherein a convexo-concave structure is formed on a thin film which is formed on a surface of a glass substrate and is mainly made of an inorganic material showing superior absorption characteristics to that of the glass substrate, by radiation  
25 of a laser beam having a periodic optical intensity distribution.

8. An optical diffraction element as defined in Claim 7, wherein a depth of concave portions of the convexo-concave structure formed by the radiation of said laser beam  
30 is equal to a thickness of the thin film formed on the surface of said glass substrate.

9. A method for manufacturing an optical element on a surface of which dielectric convex portions, which are formed with laminated film layers of at least two kinds of dielectric materials which are different in permittivity, are periodically aligned so as to have a grating constant corresponding to a wavelength of a light, comprising the steps of:

forming a dielectric multiple film layer on a surface of a substrate;

radiating a laser beam having an intensity distribution onto said dielectric multiple film layer; and

removing a portion of the dielectric multiple film layer depending on the intensity distribution of the laser beam by fusion, evaporation or ablation which occurs by making said dielectric multiple film layer absorb energy from the laser beam radiated thereon, so as to leave the other portions as the periodically aligned dielectric convex portions having a grating constant corresponding to the wavelength of the beam.

10. A method for manufacturing an optical element as defined in Claim 9, wherein said dielectric multiple film layer is formed by laminating at least two kinds of film layers, which are selected from silicon oxide, titanium oxide, cerium oxide, germanium oxide, magnesium fluoride, calcium fluoride, and tantalum oxide.

11. A method for manufacturing an optical element as defined in Claim 9, wherein said laser beam has a periodic intensity distribution in one direction, and said laser beam having a periodic intensity distribution in one direction is obtained through a phase mask or interference between two laser beams.

12. A method for manufacturing an optical element as defined in Claim 9, wherein said laser beam has periodic intensity distributions in two directions, and said laser beam having the periodic intensity distributions in two  
5 directions is obtained through interference among at least three laser beams.